
PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project

Impact Of Flow Regulation On Riparian Cottonwood Ecosystems

BPA project number: 20034

Contract renewal date (mm/yyyy): ☐ **Multiple actions?**

Business name of agency, institution or organization requesting funding
BioQuest International Consulting Ltd.

Business acronym (if appropriate) BQI

Proposal contact person or principal investigator:

Name	<u>Bob Jamieson</u>
Mailing Address	<u>Box 73,</u>
City, ST Zip	<u>Ta Ta Creek B.C. VOB 2HO</u>
Phone	<u>250-422-3322</u>
Fax	<u>250-422-3322</u>
Email address	<u>bjamieson@cintek.com</u>

NPPC Program Measure Number(s) which this project addresses

Resident Fish -10.3.A -Flathead and 10.3.B -Libby, (no notation found for Methow and Yakima). The white sturgeon and burbot program on the Kootenai River is also associated with this project. Section 11. -Resident Wildlife -11.2.E.1

FWS/NMFS Biological Opinion Number(s) which this project addresses

This project is indirectly related to the Koot. Sturgeon B.O. and NMFS Hydrosystem Operations B.O.

Other planning document references

This proposal will provide additional benefits from the spring releases for white sturgeon on the Kootenai River, affecting both US and Canadian portions of the river. Reference will also be required with the Watershed co-ordination project for the Kootenai River Watershed (9608720). The importance of riparian cottonwood systems has been recognized in a variety of planning documents in B.C. In some areas, issues are being addressed by the Watershed Restoration Program of Forest Renewal BC

Short description

Enhance riparian cottonwood ecosystems through a basin wide inventory and assessment of the timing and duration of springtime flows that will benefit not only anadromous and resident fish, but also lead to the natural recruitment of cottonwoods below dams

Target species

This proposal is concerned with an specific ecosystem rather than specific species. Priority species are black cottonwood, resident fish, otter, beaver, bald eagle great blue heron, , black-capped chickadee, ruffed grouse and migrating songbirds

Section 2. Sorting and evaluation**Subbasin**

Upper Columbia-Flathead and Kootenai subbasins

Lower Mid-Columbia- Yakima subbasin

Upper Mid-Columbia- Methow subbasin

Evaluation Process Sort

CBFWA caucus	Special evaluation process	ISRP project type
Mark one or more caucus	If your project fits either of these processes, mark one or both	Mark one or more categories
<input checked="" type="checkbox"/> Anadromous fish <input checked="" type="checkbox"/> Resident fish <input checked="" type="checkbox"/> Wildlife	<input type="checkbox"/> Multi-year (milestone-based evaluation) <input type="checkbox"/> Watershed project evaluation	<input type="checkbox"/> Watershed councils/model watersheds <input type="checkbox"/> Information dissemination <input type="checkbox"/> Operation & maintenance <input type="checkbox"/> New construction <input checked="" type="checkbox"/> Research & monitoring <input checked="" type="checkbox"/> Implementation & management <input type="checkbox"/> Wildlife habitat acquisitions

Section 3. Relationships to other Bonneville projects

Umbrella / sub-proposal relationships. List umbrella project first.

Project #	Project title/description

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
9608720	Overall watershed coordination for the Kootenai River.	cooperation on overall watershed issues.
8806400	Conservation of White Sturgeon in the Kootenai River.	analysis of the value of spring releases for more than one use
9141	Riparian recovery in relation to salmon habitat	background on the importance of riparian values to salmon.
9089	Classification system for riparian vegetation in the Lower Columbia	background research

Section 4. Objectives, tasks and schedules***Past accomplishments***

Year	Accomplishment	Met biological objectives?

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Identify and document the acres of riparian cottonwood sites flooded by reservoirs in the Flathead, Kootenay, Yakima and Methow sub-basins.	a	a. Review 1930's air photos were available.
		b	Review governmental reports and historical documents
		c	Collect data from local residents and historical societies
		d	Map historic native cottonwood stands inundated by reservoirs and agricultural diversions based on information collected in a-c.
		e	Map the historic distribution of native cottonwoods lost to flooding
		f	Create a GIS/GPS template of former cottonwood stands.

2	Identify remnant riparian cottonwood sites in these sub-basins.	a	Review current aerial and satellite imagery and other resource-based maps.
		b	Review governmental assessments of riparian corridors (where available).
		c	Use recent air photos to document cottonwood stands by river reach
		d	Input these data into a GIS/GPS template for remnant cottonwood stands
3	Document the ecological condition of remnant riparian cottonwood sites in these sub-basins.	a	Review governmental assessments of riparian corridors (where available).
		b	Selectively determine the ecological status of remnant stands, using an innovative sampling regime (see methods).
		c	Identify river reaches where remnant stands remain at risk due to flow regulation.
4	Use sampled remnant stands (Objective 3) to calibrate satellite imagery for the remaining sub-basins, as proposed for year 2-4 of this project.	a	Coordinate on-the-ground data collection with the integration and calibration requirements of satellite imagery analyses in the second stage of this project.
		b	Collect and convert data to a GPS/GIS format compatible with satellite imagery data.
5	Analyse current flow management regimes below existing dams.	a	Complete a literature review and analysis of water management regimes below dams in the Flathead, Kootenay, Methow and Yakima subbasins.
		b	Discuss flow regimes with dam operators, resource managers and research biologists working in these areas.
		c	Document seasonal flow release schedules for white sturgeon and other fisheries.
6	Develop options for altering flows to maintain remnant stands and promote natural patterns of cottonwood recruitment.	a	Describe optimal flow releases for cottonwood recruitment and stand rejuvenation.

		b	Compare flow requirements of cottonwood with flow releases for fish.
		c	Discuss current flow regimes with dam operators, resource managers and biologists.
		d	Provide an overview of options for flow regimes that meet mutual objectives for fish, other enhancement actions, and the rejuvenation of riparian cottonwood ecosystems.

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	10/1999	3/2000	none	none	15.00%
2	10/1999	9/2000	none	none	15.00%
3	4/2000	9/2000	none	none	35.00%
4	10/1999	9/2000	none	none	10.00%
5	10/1999	9/2000	none	none	15.00%
6	10/1999	9/2000	none	none	10.00%
				Total	100.00%

Schedule constraints

None expected in first year.

Completion date

September 1, 2000.

Section 5. Budget

FY99 project budget (BPA obligated):

FY2000 budget by line item

Item	Note	% of total	FY2000
Personnel			
Fringe benefits			
Supplies, materials, non-expendable property	air photos and maps	% 2	4,000
Operations & maintenance			
Capital acquisitions or improvements (e.g. land, buildings, major equip.)	Trimble Pro XR GPS and 3 8mm increment borers	% 9	14,250
NEPA costs			
Construction-related support			
PIT tags	# of tags:		
Travel	field work and consultation	% 4	6,784
Indirect costs			
Subcontractor	(for seven members of the team)	% 83	123,000
Other			
TOTAL BPA FY2000 BUDGET REQUEST			\$148,034

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount (\$)
Columbia Basin Trust	Funding is not confirmed. A request will be made in the fall of 1999 for FY 2000 funding, based on the area of the Canadian portion of the Basin (15-20%).		
Columbia Basin Fish and Wildlife Compensation Program	Funding is not confirmed. A request will be made in the fall of 1999 for FY 2000 funding, based on the area of the Canadian portion of the Basin (15-20%).		
Total project cost (including BPA portion)			\$148,034

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	\$175,000	\$175,000	\$175,000	\$175,000

Section 6. References

Watershed?	Reference
<input type="checkbox"/>	Baker, W.L. 1990. Climatic and Hydrologic Effects on the Regeneration of <i>Populus angustifolia</i> James along the Animas River, Colorado. <i>J. of Biogeography</i> 17: 59-73.
<input type="checkbox"/>	Beschta, R.L. 1991. Stream habitat management for fish in the NW United States: The role of riparian vegetation. <i>Amer. Fish. Soc. Symp.</i> 10:53-58.
<input type="checkbox"/>	Braatne J.H., S.B. Rood, and P.E. Heilman. 1996. Life history, ecology and conservation of riparian cottonwoods in North America. In: <i>Biology of Populus and its implications for management and conservation</i> , R.F Stettler, H.D. Bradshaw, Jr., P.E. Heilman
<input type="checkbox"/>	Braatne, J.H. 1997. Genetic structure of isolated populations of Plains Cottonwood (<i>Populus deltoides</i> var. <i>occidentalis</i>) along the lower Snake and Columbia Rivers. A report prepared for the US Forest Service and Boise Cascade Corporation. 44p.
<input type="checkbox"/>	Braatne, J.H., S.B. Rood, and R. Simons. 1998. Life history, ecology and distribution of riparian vegetation in the Hells Canyon Recreation Area. A detailed study plan prepared for the Idaho Power Company. 88p.
<input type="checkbox"/>	Braatne, J.H. 1998. Annual Review of the Joint BLM/USFS Black Cottonwood Restoration Program on the lower John Day River. Prepared for the US Forest Service and Bureau of Land Management, Prineville, Oregon. 33p.
<input type="checkbox"/>	Bradley C.F., F. Reintjes, and J. Mahoney, 1991. The Biology and Status of Riparian Poplars in Southern Alberta, World Wildlife Fund Canada and Forestry, Lands & Wildlife, Fish and Wildlife Division, pp. 85.
<input type="checkbox"/>	Bradley C., and D. Smith, 1986. Plains Cottonwood Recruitment and Survival on a Prairie Meandering River Floodplain, Milk River, Southern Alberta and Northern Montana, <i>Canadian Journal of Botany</i> , 64: 1433-1442.
<input type="checkbox"/>	Bradley C., and D. Smith, 1984. Meandering Channel Response to Altered Flow Regime: Milk River, Alberta and Montana., <i>Water Resources Research</i> , 20: 1913-1920.
<input type="checkbox"/>	Cooley, N. J. and B. Jamieson 1997. Identification of Options for Environmental Enhancement in the Columbia River basin. For: Columbia Basin Trust.
<input type="checkbox"/>	Debano L.F., and L.J. Schmidt, 1990. Potential for enhancing riparian habitat in the southwestern United States with watershed practices, <i>Forest Ecology and Management</i> 33/34: 385-403.
<input type="checkbox"/>	Dunlap, J.M., P.E. Heilman, and R.F.Stettler. 1994. Genetic variation and

	productivity of <i>Populus trichocarpa</i> and its hybrids. VII. Survival and two-year growth of native black cottonwood clones from four river valleys in Washington. <i>Can. J. For. Res.</i> 24:
<input type="checkbox"/>	Dunlap, J.M. and R.F. Stettler. 1998. Genetic variation and productivity of <i>Populus trichocarpa</i> and its hybrids. X. Trait correlations in young black cottonwood from four river valleys in Washington. <i>Trees</i> 13: 28-39.
<input type="checkbox"/>	Dunstone, N. and M.L. Gorman. 1998. Behavior and Ecology of Riparian Mammals. Cambridge Press, London, UK.
<input type="checkbox"/>	Fenner P., W. Brady, and D. Patton, 1985. Effects of Regulated Water Flow on Regeneration of Fremont Cottonwood, <i>J. of Range Management</i> 38: 135-138.
<input type="checkbox"/>	Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An ecosystem perspective of riparian zones. <i>BioScience</i> 41: 540-551.
<input type="checkbox"/>	Jamieson, B. and E. Hennan 1998. An Operational Management Plan for the Columbia Wetlands Wildlife Management Area. For: Wildlife Branch, Min. of Env't, Lands and Parks, Cranbrook office.
<input type="checkbox"/>	Jamieson, B., G. Allen, M.L. Polzin and S.B. Rood 1997. Elk Valley Riparian Assessment. For: Columbia Basin Fish and Wildlife Compensation Program, Nelson, B.C.
<input type="checkbox"/>	Jamieson, B. 1997. Identification of Issues and Opportunities in terrestrial ecosystem management in the Columbia River basin. For: Columbia Basin Trust.
<input type="checkbox"/>	Jamieson, B. and I.A. Ohanianian, 1993. A Land Management Strategy for Wildlife in the East Kootenay Trench. Wildlife Branch, Cranbrook office, Ministry of Environment, Lands and Parks.
<input type="checkbox"/>	Johnson, W.C., R.L. Burgess, and W.R. Keammerer, 1976. Forest Overstory Vegetation and Environment on the Missouri River Floodplain. <i>Ecol. Monogr.</i> 46: 58-84.
<input type="checkbox"/>	Johnson, W.C. 1992. Dams and riparian forests: Case study from the upper Missouri River, <i>Rivers</i> , 3: 229-242.
<input type="checkbox"/>	Johnson, W.C. 1994. Woodland Expansion in the Platte River, Nebraska: Patterns and Causes. <i>Ecological Monographs</i> . 64: 45-84.
<input type="checkbox"/>	Johnson, W.C., M.D. Dixon, R. Simons, S. Jenson and K.Larson. 1995. Mapping the response of riparian vegetation to possible flow reductions in the Snake River, Idaho. <i>Geomorphology</i> 13: 159-173.
<input type="checkbox"/>	Lonard, R. I., F.W. Judd, J.H. Everitt, D.E. Escobar, M.R. Davis, M.N. Crawford and M.D. Desai. 1998 Monitoring Native Riparian Forest Vegetation: Color Infared film aids aerial change evaluation in the lower Rio Grande. <i>EOM</i> : 32-35.
<input type="checkbox"/>	McKay, S.J. 1997. The impact of river regulation on establishment processes of riparian black cottonwood. MSc. thesis, University of Washington, Seattle. 85 pp.
<input type="checkbox"/>	Mahoney J.M., and S.B. Rood, 1991. A device for studying the influence of declining water table on poplar growth and survival, <i>Tree Physiology</i> , 8: 305-

	314.
<input type="checkbox"/>	Mahoney J.M., and S.B. Rood, 1992. Response of a hybrid poplar to water table decline in different substrates, <i>For. Ecol. Manage.</i> 54: 141-156.
<input type="checkbox"/>	Mahoney, J.M. 1996. How Rivers Affect the Establishment and Growth of Riparian Poplars. PhD. thesis, University of Calgary, Calgary, Alberta.
<input type="checkbox"/>	Mahoney, J. M. 1997. Incorporating downstream ecosystem concerns into reservoir operations in southwestern Alberta, Canada. <i>Wetlands Conf.. Soc. of Wetland Scientists.</i> Bozeman, Nt. P 86.
<input type="checkbox"/>	Mahoney, J. M. 1997. Streamflow Requirements for Cottonwood Seedling Recruitment-A Interactive Model. <i>Wetlands Dec 1998 Volume 8</i> pages 634-645.
<input type="checkbox"/>	Mahoney J.M., and S.B. Rood, 1998. Streamflow Requirements for Cottonwood Seedling Recruitment-A Integrated Model. <i>Wetlands</i> 8:634-645.
<input type="checkbox"/>	Manning, M.E., Engleking, L.D. and Jensen M.E. 1998 (in press) Riparian Plant association groups and assoc. valley types of the Interior Columbia River basin ecosystem mgnt project assessment area. Portland OR. Dep't of Agric., PNW Res. Station.
<input type="checkbox"/>	Martinsen, G.D. and T.G. Whitham. 1994. More birds nest in hybrid cottonwood trees. <i>Wilson Bull.</i> 106:474-481.
<input type="checkbox"/>	Naiman et al. 1992. Fundamental elements of ecologically healthy watersheds in the Pacific Northwest coastal ecoregion. In: <i>Watershed Management: balancing sustainability and environmental change</i> , Springer Verlag: 126-188.
<input type="checkbox"/>	Ohanjanian, I. A. 1991. An inventory of mature and old growth stands in the Cranbrook and Invermere Timber Supply areas, with special reference to the habitat requirements of the Pileated Woodpecker. Wildlife Branch, Cranbrook office. 51p.
<input type="checkbox"/>	Ohanjanian, I.A. and I. Teske. 1996. Cottonwood Stands in the Columbia Marshes. Report to the Columbia Basin Fish and Wildlife Compensation Program. 27 pp.
<input type="checkbox"/>	Polzin, M.L. 1998. River and Riparian Dynamics and Black Cottonwoods in the Kootenay River Basin, British Columbia and Montana, MSc. thesis, University of Lethbridge, Lethbridge, Alberta pp-224.
<input type="checkbox"/>	Quigley, T.M., S. T. Arbelbide (ed.) 1997. Assessment of Ecosystem Components in the Interior Columbia Basin and parts of the Klamath and Great Basins. 4 vols.
<input type="checkbox"/>	Rood S.B. and A. Kalischuk, 1998. Cottonwood seedling recruitment following the flood of the century of the Oldman River, Alberta, Canada. <i>Wetlands</i> (In press).
<input type="checkbox"/>	Rood S.B. and C. Gourley, 1996. Instream flows and the restoration of riparian cottonwoods along the lower Truckee River, Nevada. Report prepared for the US Fish and Wildlife Service and The Nature Conservancy, Reno, NV. pp. 27.
<input type="checkbox"/>	Rood S.B., J.M. Mahoney, D.E. Reid, and L. Zilm, 1995. Instream Flows and the Decline of Riparian Cottonwoods Along the St. Mary River. <i>Can. J. Bot.</i>

	73:1250-60.
<input type="checkbox"/>	Rood, S.B., and J.M. Mahoney, 1995. River Damming and Riparian Cottonwoods Along the Marias River, Montana. <i>Rivers</i> 5: 195-207.
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<input type="checkbox"/>	Rood S.B., and J.M. Mahoney, 1990. Collapse of Riparian Poplar Forests Downstream from Dams in Western Prairies: Probable causes and Prospects for Mitigation, <i>Environmental Management</i> , 14: 451-464.
<input type="checkbox"/>	Rood S.B., and S. Heinze-Milne, 1989. Abrupt Downstream Forest Decline Following River Damming in Southern Alberta. <i>Can. J. Bot.</i> 67: 1744-1749.
<input type="checkbox"/>	Scott M.L., J.M. Friedman, G.T. Auble, 1996. Fluvial Process and the Establishment of Bottomland Trees, <i>Geomorphology</i> 14: 327-339.
<input type="checkbox"/>	Scott M.L., G.T. Auble, J.M. Friedman, L.S. Ischinger, E.D. Eggleston, M.A. Wondzell, P.B. Shafroth, J.T. Back, and M.S. Jordan, 1993. Flow Recommendations for maintaining Riparian Vegetation Along the Upper Missouri River, Montana.
<input type="checkbox"/>	Segelquist C.A., M.L. Scott and G.T. Auble, 1993. Establishment of <i>Populus Deltoides</i> Under Simulated Alluvial Groundwater Declines. <i>Am. Midl. Nat.</i> 130: 274-285.
<input type="checkbox"/>	Snyder W.D., and G.C. Miller, 1991. Changes in Plains Cottonwoods along the Arkansas and South Platte Rivers Eastern Colorado, <i>Prairie Nat.</i> 23: 165-176.
<input type="checkbox"/>	Strahler, A.N., A.H. Strahler, 1973. <i>Environmental Geoscience: Interaction between Natural Systems and Man</i> . Hamilton Publishing: Santa Barbara, CA. pp. 511.
<input type="checkbox"/>	Stromberg J.C., and D.T. Patten, 1992. Mortality and Age of Black Cottonwood Stands Along Diverted and Undiverted Streams in the Eastern Sierra Nevada, California. <i>Madrono</i> 39: 205-223.
<input type="checkbox"/>	Stromberg J.C., and D.T. Patten, 1991. Instream Flow Requirements for Cottonwoods at Bishop Creek, Inyo County, California. <i>River</i> 2: 1-11.
<input type="checkbox"/>	US Army Corps of Engineers (USACE) 1996. Seattle District. http://www.nps.usace.armymil/internet site.
<input type="checkbox"/>	Whitham, T.G., K.D. Floate, G.D. Martinsen, E.M. Driebe and P. Keim. 1996. Ecological and evolutionary implications of hybridization: <i>Populus</i> -herbivore interactions. . In: <i>Biology of Populus and its implications for management and conservation</i> .
<input type="checkbox"/>	Williams G.P., and M.G. Wolman 1984. Downstream Effects of Dams on Alluvial Rivers, Geological Survey Professional Paper 1286, US Government Printing Office, pp. 83.
<input type="checkbox"/>	
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PART II - NARRATIVE

Section 7. Abstract

Riparian cottonwoods provide critical habitat for a diverse assemblage of fish and wildlife species indigenous to the Pacific Northwest and are important to maintaining the quality of spawning areas, rearing sites and adult fish habitat. With the damming of the Columbia River and the widespread clearing of floodplain forests, the structure and function of riparian cottonwood ecosystems has been significantly degraded. Where native cottonwoods still occur downstream of dams, they lack the natural flow variability that is essential to sustaining these critical ecosystems. Objective 1. is to provide an overview of the areal extent and ecological status of these ecosystems in the Columbia Basin, following a step-wise assessment that will begin with the Flathead, Kootenai, Yakima and Methow Rivers. These initial study areas will provide a representative sample of the fluvial and ecological environments occupied by riparian cottonwoods within the basin. GIS/GPS-based methodologies will be combined with historic air photo interpretation to quantify the areal extent of riparian cottonwood ecosystems within these subbasins. In years 2 to 4, satellite imagery will be used to facilitate the inventory and assessment of the remainder of the basin. Objective 2. is to assess specific flow management practices related to the timing and duration of springtime flows, and to develop flow regimes that benefit not only anadromous and resident fish, but also encourage natural recruitment of cottonwoods below dams within the Columbia Basin. Objective 3. Is to promote international co-operation on the management of riparian ecosystems within the Columbia Basin.

Section 8. Project description

a. Technical and/or scientific background

Ecological Function and Biodiversity Value: Native cottonwoods provide critical habitat and support high levels of biodiversity within riparian corridors (Finch and Ruggerro 1993, Dunstone and Gorman 1998, Whitham et al. 1996). They enhance the quality of aquatic habitats by moderating water temperatures (Debano and Schmidt 1990), and supplying carbon, nutrients and large woody debris that provide habitat and sustenance for a variety of instream and streamside invertebrates important to fish diets. Cottonwood forests are commonly associated with major salmon spawning redds, while also providing important habitat for resident and migrating songbirds (Martinsen and Whitham 1994, Whitham et al. 1996). Recent research by the Canadian Wildlife Service and others have found that these habitats are critical for songbirds as resting and feeding areas during migration (R. Millikin, pers. comm.). The Pileated woodpecker is an important cavity excavator in these systems (Ohanjanian 1991), using large black cottonwood trees and snags for nesting. Their abandoned cavities are used by other cavity-nesters, such as waterfowl (wood ducks, mergansers, golden eye), flying squirrels

and several species of bats (Dunstone and Gorman 1998). These systems are also important for otter*, beaver, ruffed grouse*, great blue heron* (rookery sites), owls, bald eagle*, golden eagle and peregrine falcon* (during migration). Riparian ecosystems are thus identified as a high priority in the 1994 Col. Basin Fish and Wildlife Program (Sec. 11.2E.1). * species above are listed in Table 11-1-3.

Riparian cottonwood ecosystems play an important role in the structure and function of riverine habitats. Quigley and Arbelbide (1997) among others have noted that riparian cottonwoods:

1. dissipate stream energy associated with peakflows, stabilize riverbanks, reduce erosion and improve water quality (Debano and Schmidt 1990, Strahler and Strahler 1973);
2. filter sediment, capture bedload and promote floodplain development;
3. improve flood water retention and groundwater recharge,
4. provide shade and reduce water temperatures which benefit a wide range of resident and anadromous fish (Debano and Schmidt 1990).
5. promote a diverse mosaic of ponds and river channel habitats that are necessary for fish production, waterfowl breeding and other wildlife uses, and
6. support higher levels of biodiversity than streamside conifers (Naiman et al. 1992, Whitham et al. 1996).

Resource Issues: Several studies from across western North America have revealed the steady decline of extent and health of riparian cottonwood ecosystems (Rood and Mahoney 1990; Bradley et al. 1991, Braatne et al. 1996, Mahoney 1996). The primary causes of these declines have been woodland clearing and impacts due to water diversions and damming (Braatne et al. 1996). Most of the studies on dam-induced declines have occurred along rivers in Southern Alberta and other rivers supporting prairie and Fremont cottonwoods (Johnson et al. 1976, Bradley and Smith 1986, Rood and Heinze-Milne 1989, Rood and Mahoney 1990, Rood and Bradley 1993, Snyder and Miller 1991, Stromberg and Patten 1992, Johnson 1992, and Rood et al. 1995, Polzin 1998). This research has shown that declines in riparian cottonwoods are caused primarily by the suppression of seedling recruitment. Since cottonwoods are a relatively short-lived tree (100-200 years), declines in recruitment over the past century have lead to the widespread loss of riparian cottonwood ecosystems.

The recruitment of cottonwood seedlings is dependent on dynamic fluvial processes (Bradley and Smith 1984, Rood and Mahoney 1990, Rood and Mahoney 1995, Braatne et al. 1996, Mahoney 1996, Scott et al. 1996). Dynamic seasonal flow patterns, combined with periodic flooding, produce moist, barren substrates that are necessary for seedling recruitment (Bradley and Smith 1986, Rood and Mahoney 1990, Rood and Mahoney 1994, Scott et al. 1996). After germination on these nursery sites, the roots of young seedlings must also keep pace with declining river levels (root growth averages 1.5 cm per day); Mahoney and Rood 1991, 1992, 1998, Selgelquist et al. 1993, Johnson 1994, Rood et al. 1995). If river levels decline too rapidly, young seedlings rapidly succumb to drought stress. Older and larger cottonwood trees are also dependent on periodic flooding and recharging of the alluvial water table (Johnson and Jones 1977; Rood and Heinze-Milne

1989; Rood and Mahoney 1990; Snyder and Miller 1991; Stromberg and Patten 1992). Dams that attenuate spring peakflows and reduce summer baseflows induce significant levels of drought stress among all age-classes, and thereby promote a decadent age-structure among local populations (Fenner et al. 1985, Bradley and Smith 1986, Rood and Mahoney 1990, Stromberg and Patten 1991, Scott et al. 1996). This will lead to the eventual loss of these ecologically important stands.

In recent years, some researchers have successfully applied their knowledge of the life history and ecology of cottonwoods to promote natural patterns of recruitment below dams on several western rivers (Rood and Gourley 1996, Rood and Kalischuk 1998). In these cases, high water volumes available during "wet years" were released in a manner that was compatible with seed dispersal and establishment of cottonwood seedlings. These practices are now widely accepted and promoted by resource managers in Alberta (Mahoney 1997) and Nevada (Rood and Gourley 1996,). Our study will systematically identify opportunities to enhance the recovery of riparian cottonwood ecosystems through selective flow management practices in the Basin. We are confident that these flow management practices can be developed in cooperation with efforts to promote the recovery of other ecosystem functions,, such as the flushing of sediments from fish rearing areas (Anon. 1995) and the provision of water conditions appropriate for the spawning of sturgeon.

Canadian experience in the Columbia Basin: Jamieson and Ohanjanian (1993) and Cooley and Jamieson (1997) identified riparian cottonwood ecosystems as a major conservation issue lacking adequate attention in the Canadian portion of the Basin. Jamieson et al. (1997) identified a number of options for maintaining cottonwood stands along the Elk River. M.L. Polzin (1998) showed that cottonwood recruitment on the free-flowing portions of the Elk and Kootenay Rivers in Canada was significantly higher than stands growing along the Kootenai River below the Libby dam in Montana. Cottonwood stands on the shore of Kootenay Lake which, prior to damming, fluctuated 1-2 m (3-6 feet) annually, have also declined. Regulated flows below the Lardeau dam may also be creating long term problems with cottonwood recruitment on the Lardeau/Duncan delta (B. Herbison, pers. comm.). In the Upper Columbia, Ohanjanian and Tesky (1996) documented the status of cottonwood stands in wetlands at the source of the Columbia system. Jamieson and Hennen (1997) developed a management plan for the Columbia Wetlands that identified the monitoring of the status and health of cottonwood stands as a management priority. Rood et al. (1995) assessed cottonwood recruitment along isolated reaches of the Columbia River in the Castlegar to Trail area). To date, there has not been a systematic assessment of riparian cottonwoods in the Kettle and Okanogan Rivers (Mike Carlson, pers. comm.).

US experience in the Columbia Basin: A limited number of research and restoration projects (see below) have been directed toward studying riparian cottonwoods in the US portion of the Columbia Basin. Quigley and Arbelide (1997) discuss the nature of "riparian woodland habitats", but noted that most riparian cottonwood sites were missed in their analysis. US Dept. of the Interior (1994) also conducted a broad survey of 15,300 miles of

riparian corridor, in which different reaches were rated according to their degree of ecosystem function. Another major review of riparian ecosystems within the Interior Columbia Basin was recently completed by Manning and his colleagues (1998). Collectively, these studies conclude that “flooding disturbance has been virtually eliminated” and that “mid-seral stages have increased substantially” within the Columbia Basin. “The lack of recruitment by early seral riparian species and the senescence of larger, old trees in late seral riparian woodlands” were emphasized as a significant long-term problem requiring systematic evaluation.

Specific research projects on riparian cottonwoods have been completed on selected reaches of the following rivers: Clark fork and Flathead (Steve Clayton MSc. thesis, Anon 1995, Jack Stanford pers. comm./unpublished data), Kootenai (Polzin 1998), Upper and Middle Snake River (Mike Merigliano Ph.D. dissertation, Johnson et al. 1995 and Idaho Power Company, unpublished data), Lower Snake River (Braatne et al. 1998), John Day (Braatne 1998), Yakima (Dunlap et al. 1994, Dunlap and Stettler 1998), Cowlitz (McKay 1997), Willamette (Beschta 1991, Gregory et al. 1991, Sedell 1992, Swanson et al. 1998)

b. Rationale and significance to Regional Programs

Monitoring and research on riparian cottonwood ecosystems has been carried out on several reaches within the Columbia River Basin. However, background data on these ecosystems needs to be systematically assembled to provide a clear, basin wide assessment of remnant cottonwood stands and an analysis of the affect of current dam operations on their long-term survival. In many cases, it may be possible to promote cottonwood recruitment through springtime flow releases similar to the flow regimes being tested on the Kootenai River to assist the recruitment of white sturgeon. Further, this information needs to be assembled in a GPS/GIS framework that is compatible with regional databases to facilitate strategic resource planning within the basin (See Study Context and Methods below).

Riparian cottonwoods represent one of the most critical ecosystems affected by dam construction and operation within the Columbia Basin (Jamieson and Ohanjanian 1995). These ecosystems support important ecological components that have not received the level of management concern that would be suggested by their rarity, degree of risk and their importance to ecosystem function in relation to both terrestrial and aquatic resources. This project will provide an overview of the status of these systems, as background for resource managers and decision-makers and will document options for rehabilitating these systems where they occur on flow-regulated rivers. It will address issues identified in the Col. Basin F/W Plan for anadromous fish, resident fish and wildlife within the context of returning near natural flow regimes and groundwater recharge to riparian ecosystems. This project provides an important example of ecosystem rehabilitation that meets multiple resource objectives and promotes international co-operation on a common ecological problem.

c. Relationships to other projects

Springtime flow releases were initiated in 1992 from the Libby Reservoir in an attempt to stimulate reproduction and recruitment in white sturgeon populations (Project 8806400 and others) which were declared endangered in 1994 (USACE 1996). These releases appear to mimic the conditions required for cottonwood recruitment. In a similar manner, releases from Hungry Horse Dam to flush sediments from river gravels on the Lower Flathead (Anon. 1995) could be modified to support cottonwood recruitment. Other related projects ongoing or proposed are:

Project 9141: riparian recovery and implications for salmon.

Project 9089: inventory and classification of riparian vegetation in sub-drainages of WA.

Project 9062: restoration of riparian vegetation on the lower end of the Columbia.

d. Project history (for ongoing projects)

This is a new project proposal, present work in the field is documented in Sec 8A.

e. Proposal objectives

During the course of this project, our team will assemble a scientifically-rigorous database that promotes an understanding of the impacts of flow regulation upon riparian cottonwood ecosystems within the Columbia Basin. We will address the following questions:

1. How many acres (river miles) of riparian cottonwood have been flooded by reservoirs?
2. How many acres (river miles) of riparian cottonwood remain in the Basin?
3. What proportion of remnant cottonwood stands remain in healthy condition, compared to pre-contact and pre-dam conditions?
4. What remnant cottonwood stands remain at risk due to flow regulation?
5. Can current flow releases to support anadromous and resident fisheries be modified to promote cottonwood recruitment and enhance the recovery of riparian ecosystems below existing dams?

During the first year of this project, our efforts will focus upon answering these questions within the Flathead, Kootenai, Yakima and Methow sub-basins. Specific objectives and tasks include:

1. Identify and document the acres of riparian cottonwood sites flooded by reservoirs in the Flathead, Kootenay, Yakima and Methow sub-basins.

Tasks and deliverables:

- a. Review 1930's air photos (where available).
- b. Review governmental reports and historical documents (where available).
- c. Collect data from local residents and historical societies.
- d. Map historic native cottonwood stands inundated by reservoirs and agricultural diversions based on information collected in a-c.
- e. Map the historic distribution of native cottonwood stands lost to other land uses.
- f. Create a GIS/GPS template of former cottonwood stands.

2. Identify remnant riparian cottonwood sites in these sub-basins.

Tasks and deliverables:

- a. Review current aerial and satellite imagery and other resource-based maps.
- b. Review governmental assessments of riparian corridors (where available).
- c. Use recent air photos to document cottonwood stands by river reach (see methods)
- d. Input these data into a GIS/GPS template for remnant cottonwood stands.

3. Document the ecological condition of remnant riparian cottonwood sites in these sub-basins.

Tasks and deliverables:

- a. Review governmental assessments of riparian corridors (where available).
- b. Selectively determine the ecological status of remnant stands, using an innovative sampling regime (see methods).
- c. Identify river reaches where remnant stands remain at risk due to flow regulation.

4. Use sampled remnant stands (Objective 3) to calibrate satellite imagery for the remaining sub-basins, as proposed for year 2-4 of this project.

Tasks and deliverables:

- a. Coordinate on-the-ground data collection with the integration and calibration requirements of satellite imagery analyses in the second stage of this project.
- b. Collect and convert data to a GPS/GIS format compatible with satellite imagery data.

5. Analyse current flow management regimes below existing dams.

Tasks and deliverables:

- a. Complete a literature review and analysis of water management regimes below dams in the Flathead, Kootenay, Methow and Yakima subbasins.
- b. Discuss flow regimes with dam operators, resource managers and research biologists working in these areas.
- c. Document seasonal flow release schedules for white sturgeon and other fisheries.

6. Develop options for altering flows to maintain remnant stands and promote natural patterns of cottonwood recruitment.

Tasks and deliverables:

- a. Describe optimal flow releases for cottonwood recruitment and stand rejuvenation.
- b. Compare flow requirements of cottonwood with flow releases for fish.
- c. Discuss current flow regimes with dam operators, resource managers and biologists.
- d. Provide an overview of options for flow regimes that meet mutual objectives for fish, other enhancement actions, and the rejuvenation of riparian cottonwood ecosystems.

f. Methods

1. Summary of existing data on selected sub-basins (Objectives 1 and 2)

Data will be collected on pre-dam and present stands, using air photos and where available, landsat imagery. The extent of stands on older air photos will be outlined and the area extent measured and converted to GIS format. More recent aerial photographs will be scanned and converted to GIS format using techniques developed in the province of Alberta. The option of delineating stands of different ages will be tested using infra-red Landsat data from photos taken in spring. The new leaves on cottonwood trees in that period contrast sharply with other vegetation (S. Nelson, pers. comm.). All stands >5 ac will be mapped for all river reaches that support > 100 ac of cottonwood stands per linear mile of river length.

3. Ecological condition of remnant cottonwood stands (Objective 3)

The ecological condition of remnant cottonwood stands will be assessed on the basis of a random-stratified sampling scheme within the Kootenay, Flathead, Methow and Yakima sub-basins. Ten separate study corridors (patch size derived from aerial photographic data) will be randomly selected within each sub-basin for a quantitative assessment of stand conditions. Study corridors will be equally partitioned relative to patch size and location above and below dam locations. As cottonwood establishment is the product of episodic fluvial events, multiple stands of differing age/size class distributions are reflective of a healthy riparian cottonwood ecosystem. Within selected corridors of riparian cottonwood, the age and size class distribution of remnant stands will be systematically assessed using belt-transects oriented perpendicular to the main channel. A minimum of five plots (5 x 20m) along each transect would be measured per stand. Within each plot, tree age, height, diameter at breast height, percent cover and general crown characteristics (width/height) will also be assessed. Methods follow protocols of Johnson et al. (1995), Scott et al. (1996), and Rood and Kalischuk (1998).

The areal extent of each stand will be mapped using GPS (Trimble Pro XR: submeter-level accuracy with mappable GIS outputs) and GIS-based methods that readily integrate with regional databases (Johnson et al. 1995). This approach is time-effective and our team has extensive experience with these methodologies within the Columbia Basin (Hells Canyon/Snake River Corridor). Our assessments will result in precise mapping of current stand conditions relative to fluvial dynamics and channel morphology. Mapping units derived from these stands will serve to calibrate satellite imagery analyses (see below). These assessments and mapping efforts will also facilitate the identification of flow prescriptions to promote natural recruitment of cottonwood throughout the basin.

4. GIS/GPS/Satellite-Based Methods (Objective 4)

The most cost-effective means of coordinating data collection within GIS/GPS/Satellite formats will be explored with regional experts (Terrasat Inc., Vancouver, BC), prior to initiation of field studies in the year 2000. We currently anticipate that data inputs from aerial photographs, GPS field locations and satellite images will be rectified to available base maps for analysis and interpretation. Several options currently exist for satellite imagery and analysis of riparian corridors. For example, there are presently several different sources of satellite images in various formats at a 5 to 28 m resolution. However, the IKONOS satellite system will be launched in June of 1999, which will provide a 3 m resolution in a multi-spectral format. IKONOS images will thus be available for this project, and could provide a high-spectral resolution capable of assessing health and stress factors in cottonwood stands. A similar approach has been tested in riparian woodlands on the Rio Grande (Lonard et al. 1998). Specific details and options for satellite-based analyses will be provided in our December 1999 proposal for our second year of funding support. At that time, we expect that options will arise for cost-sharing arrangements.

5. Analyse current flow management regimes and develop options for modifying flow regimens to maintain remnant stands and promote natural patterns of cottonwood recruitment.

Data on current flow regimes below dams in select sub-basins will be compared to flow-release models developed for cottonwood recruitment along the Oldman River and St. Mary's rivers in Alberta (Mahoney 1997) and other sites where such flow-regulated releases are being carried out and tested (Rood and Gourley 1997, Rood and Kalischuk 1998). Consultation with resource biologists and hydro-system managers will be required to define realistic options, given the diverse requirements of power production, habitat rejuvenation, etc.

6. Project Monitoring and Evaluation

Within team monitoring and evaluation will be carried out by Dr. S. Rood and Dr. J. Braatne on technical issues and scientific methodologies. Bob Jamieson, in consultation with NPPC and BP Fish and Wildlife staff and others, will ensure coordination of research objectives and oversee implementation within the various subbasins.

Project Schedule: A schedule for the first year of the project is provided in Part A. The overall schedule for the project is:

Year 1. Inventory of riparian cottonwood sites on the Canadian and American portions of the Kootenay, Flathead, Methow and Yakima Rivers, as per the objectives provided in this proposal. Complete a report on inventory and flow release options for these subbasins.

Year 2. Inventory of the Canadian and American portions of the Okanogan, Kettle, Granby, Pend Oreille, Clark Fork, and Spokane subbasins. Explore options available for integration of satellite photography with GPS stand data (from Year 1) as a means to

calibrate satellite-derived imagery and validate satellite-based analyses. The potential application of multi-spectral photography to document stand health and condition will be tested on selected sites.

Year 3-4. Inventory the remainder of the basin in conjunction with researchers working in each subbasin and appropriate resource agencies, using data collected from selected subbasins to ground truth satellite-derived images. Complete final report on inventory and flow release options for the entire basin.

g. Facilities and equipment

All office and computer facilities, vehicles, boats and other field equipment will be provided by the contractors. This project will require the purchase of a portable GPS system (Trimble Pro XR) with sub-meter level accuracy (\$12,000.00). The rental cost for this equipment is \$100/day, however proposed usage suggests that it would be more cost effective to buy this unit. We would also need to purchase three Increment borers (30"length/8 mm dia): 3 @ \$750/each for a total cost of \$2,250.00 for time-efficient age analyses of cottonwood stands.

h. Budget

The budget developed per task is provided below.

Summary of existing data

Kootenai/Flathead (10 days*).....	\$4,000.00
Yakima/Methow (10 days).....	\$4,000.00

Aerial Photography Analysis

Kootenai/Flathead (10 days).....	\$4,000.00
Yakima/Methow (10 days).....	\$4,000.00

Field Work

Kootenai/Flathead.....	\$23,192.00
Yakima/Methow	\$23,192.00

Data Analysis

Kootenai/Flathead (20 days).....	\$8,000.00
Yakima/Methow (20 days).....	\$8,000.00

Meetings with other workers/managers

Kootenai/Flathead (5 days)	\$2,000.00
Yakima/Methow (5 days).....	\$2,000.00
Terrasat assessment of requirements for relating sampling to sat. imagery.....	\$5000.00

Mapping Inputs to GIS/GPS database

Kootenai/Flathead (5 days) \$2,000.00
Yakima/Methow (5 days)..... \$2,000.00

Report writing

2xKootenai/Flathead (10 days)..... \$4,000.00
Yakima/Methow (10 days)..... \$4,000.00

Travel and accomodation costs relating

to meetings.(separate from field work)..... \$3,000.00

Supplies (air photos, maps)..... \$4,000.00

Final Report preparation, year 1 \$18,000.00

Sub-Total..... \$120,384.00

Capital Purchase

Trimble Pro XR \$12,000.00
8 mm dia increment borer 3@\$750/each..... \$2,250.00

Capital Costs \$14,250.00

Sub-Total..... \$134,634.00

Administration of contract (10%) \$13,400.00

TOTAL PROJECT COST, YEAR 1..... \$148,034.00

* The day rate charge used to develop this budget, of \$400.00/day, is an average for the staff involved. It will vary according to level of expertise and Canadian vs US rates.

Field work costs were calculated as below.

Ecological Stand Assessments (Objective 3) : A three-person crew can sample one to two study sites per day, depending upon stand conditions (ie. number of discrete age/size class stands per site) and travel distance between sites.

Belt transect of age/size class distribution and tree cover for each stand:

2 hr x 3/team = 6 hr/stand
Three to four stands per site = 18 to 24 hr/site

With 10 study corridors sampled per river drainage (Kootenay, Flathead, Methow and Yakima), a total of 40 study sites would be measured in year 1.

A. Stand assessment: 40 sites x 15 hr/site = 600 hr:	75 person-days x \$400/day	\$30,000.00
B. Travel time between sites:	24 person-days x \$400/day	\$9,600.00
C. Daily per diem: \$28/day	72 person-days x \$28	\$2,016.00
	96 person-days x \$28	\$2,688.00
D. Transportation: (Auto @ \$0.32/mile)	6,500 miles x \$0.32	\$2,080.00
E. Subtotal:		\$46,384.00

The outyear estimates provided in Part I. do not include costs of satellite imagery since those costs are difficult to estimate at this point. Estimates will be provided in the project proposal for that year (2000/2001).

Section 9. Key personnel

Overall project management will be the responsibility of Bob Jamieson and Dr. Jeff Braatne.

The Canadian portion of the team includes:

B. Jamieson. Project Manager for the Canadian portion of the project. He is a - wildlife ecologist, resource manager and strategic planning expert with an overall knowledge of the Canadian portion of the basin and resource issues there.

Dr. Stewart Rood - Head of the Department of Biology, University of Lethbridge. Dr. Rood's primary research interest is the life history and ecology of riparian cottonwoods. He will provide overall technical direction to the project.

Mary Louise Polzin. - Field Manger. Mary Louise recently completed a thesis on cottonwood ecosystems in the Upper Kootenay River system, above and below Libby dam. She has a detailed knowledge of tools and methods required in this project.

The American portion of the team includes:

Dr. Jeffry Braatne - -University of Washington/Private Consultant -Seattle, WA

Dr. Braatne's primary research interest is the life history and ecology of riparian cottonwoods. He also has extensive field and project management experience in the American portion of the Columbia Basin.

Dr. Mike Merigliano, Research Associate at the University of Montana, Missoula. Dr. Megiliano has several years of research and restoration experience with cottonwoods on the Clark Fork, Bitterroot, Flathead and Upper Snake Rivers.

Dr. Jon Johnson -- Research Professor and Director of the Hybrid Poplar/Black Cottonwood Research Program at Washington State University-Puyallup, WA. Dr. Johnson has extensive experience in multiple research modalities on the physiology and ecology of native cottonwoods and hybrid poplars.

Dr. Joan Dunlap -- Research Associate with Poplar Research Program at the University of Washington, Seattle, WA. Dr. Dunlap has several years of research and field experience with black cottonwood on the major sub-basins of Washington and South-central British Columbia.

BOB JAMIESON

BioQuest International Consulting Ltd.
Box 73,
Ta Ta Creek, B.C.
VOB 2H0

ph 250-422-3322
fx 250-422-3322
bjamieson@cintek.com

EDUCATION:

1970 B. Sc. Department of Biology, University of Calgary, Calgary, Alberta
Member of the Association of Professional Biologists of B.C.

BACKGROUND: Bob has over 30 years experience in resource management and handling complex projects. He has a solid and diverse background as a scientist and resource manager. Bob has worked on a variety of consulting projects in the tourism field (tourism resource mapping, defining options for developing ecotourism in B.C., developing a structure for a provincial tourism organization); in land use planning (management plans for parks and wildlife areas, regional land use planning,) and in the wildlife field (movements of elk, wildlife use of avalanche paths, the distribution and pop. density of large mammals in West Africa). In recent years his primary role has been in interpreting science and scientific results from a variety of sources and applying them in long term management plans for large land areas such as the Columbia Wetlands. Because of the public interest in such projects he has developed skills in interpreting complex (and sometimes contradictory scientific results) to the public and interest groups. He has also developed expertise in working with diverse interest groups in his role as the East Kootenay coordinator for the Commission on Resources and Environment where he assisted in developing a regional land use plan for the East Kootenay. Bob has been a leader in promoting the understanding of issues related to riparian cottonwood systems in the Canadian portion of the Columbia Basin.

EMPLOYMENT HISTORY (80-98):

1980-1998: Self employed. Principle in BioQuest International Consulting Ltd.

1980-1998: President-Jamieson Ranching Ltd.

1992-1994: East Kootenay Coordinator, Commission on Resources and Environment.

POSITIONS HELD: Member of the Board, Council on Sustainability (1995-1998). The Council consists of 12 members representing broad industrial, social and environmental interests from across the province of B.C. **Member of the Provincial Round Table on the Environment and Economy (1990-1994).** Represented the Tourism sector; Chair of the Sub-Committee on Resource Accounting. **President of the Wilderness Tourism Council of B.C. (1987-89),** a industry lobby group that represented 850 wilderness-based businesses in the province.

RELEVANT PUBLICATIONS (95-98):

Jamieson, B. and E. Hennen 1998. An Operational Management Plan for the Columbia Wetlands Wildlife Management Area. For: Wildlife Branch, Min. of Env't, Lands and Parks, Cranbrook

Jamieson, B. G. Allen, M.L. Polzin and S. Rood. 1997. Elk Valley Riparian Assessment. For: Columbia Basin Fish and Wildlife Compensation Program, Nelson, B.C.

Cooley, N. J. and B. Jamieson 1997. Identification of Options for Environmental Enhancement in the Columbia River basin. For: Columbia Basin Trust.

Jamieson, B. 1997. Identification of Issues and Opportunities in terrestrial ecosystem management in the Columbia River basin. For: Columbia Basin Trust.

JEFFREY H. BRAATNE

College of Forest Resources
7703-39th Avenue NE
University of Washington
Seattle, WA 98195-2100
206.523.3739
braatne@u.washington.edu

EDUCATION:

1989 Ph.D. Department of Botany, University of Washington, Seattle
1978 B.A. Departments of Biology & Botany, University of Montana, Missoula

Additional training (94-98): Applied Fluvial Geomorphology I & II and River Restoration (Wildland Hydrology w/Dave Rosgen, Pagosa Springs, CO); Stable Isotope Ecology (BIO581, University of Utah, Salt Lake City, UT); Federal, State and Local Clean Water and Wetland Regulations I & II (Seattle Law Review Board).

BACKGROUND: Dr. Braatne is an ecologist with expertise in the ecology of riparian landscapes and the physiological ecology of riparian plants. Over the last ten years, he has been an active participant in the University of Washington/Washington State University Black Cottonwood Research Program. His research and teaching interests focus on the physiology and ecology of riparian cottonwoods and willows in western North America. Some recent research topics include: a) physiological and morphological responses of willows and cottonwoods to drought and flooding, b) fluvial/ecological modeling of the riparian plant communities, and c) impacts of stream-flow modifications on riparian plant communities and landscapes. Recent studies have focused upon the ecology of riparian plant communities along the lower Snake (Hells Canyon) and Salmon River Corridors. Dr. Braatne also teaches graduate courses on riparian landscape ecology and river restoration at the University of Washington.

EMPLOYMENT HISTORY (90-98):

Assistant Research Professor: Biology Dept., University of Lethbridge, Alberta. 1997-Present
Affiliate Assistant Professor: Forest Dept., University of Washington, Seattle, WA. 1994-Present
Independent Environmental Consultant: Seattle, WA. 1995-Present
Senior Ecologist: National Wetland Science Training Cooperative; L.C. Lee & Associates, Inc.; Springwood Associates, Inc., Seattle, WA. 1993-95
Postdoctoral Fellow: Forestry Dept., University of Washington, Seattle, WA. 1990-93

RELEVANT PUBLICATIONS (93-98):

Braatne, J.H., S.B. Rood and R. Simons. 1998. Life history, ecology and distribution of riparian vegetation in the Hells Canyon National Recreation Area. A detailed study plan prepared for Idaho Power Company. 88 p.
Braatne, J.H. 1998. The biological aspects of hybrid polar cultivation pertinent to floodplain cultivation in western North America. A report prepared for EPA (Region 10), Seattle, WA. 96 p.
Braatne, J.H. 1998. Annual Review of the Joint BLM/USFS Riparian Cottonwood Restoration Program along the John Day River, Oregon Prepared for the US Forest Service and Bureau of Land Management, Prineville, OR. 33p.
Braatne, J.H. 1997. Genetic structure of isolated populations of Plains Cottonwood (*Populus deltoides* var. *occidentalis*) along the Snake and Columbia Rivers. A report for US Forest Service & Boise Cascade Corp. 44p.
Braatne, J.H., S.B. Rood and P.E. Heilman. 1996. Life history, ecology and conservation of riparian cottonwoods in North America. In: R.F. Stettler, H.D. Bradshaw, P.E. Heilman and T.M. Hinckley (eds.), *Biology of Populus: Implications for management and conservation*. National Research Council Ottawa: 57-85.

Stewart B. Rood

Department of Biological Sciences
University of Lethbridge, Alberta, Canada T1K 3M4
phone: (403) 329-2327
fax: (403) 329-2082
email: ROOD@ULETH.CA

Education

B.Sc., (with Distinction) Physiological Psychology-Biology, University of Alberta. 1976.
Ph.D., Plant Physiology, University of Calgary. 1981.
Post-doctoral Fellowship (NSERC) , Faculty of Forestry, University of Toronto. 1982.

Employment

1983-present - Assistant and Associate Professor and currently (full) Professor, University of Lethbridge
1991-1994, 1997 - Chair, Department of Biological Sciences, University of Lethbridge
1994-1996 - Coordinator, Environmental Science Program, University of Lethbridge

Expertise

Dr. Rood is an international expert on riparian cottonwoods and the influence of damming and river flow regulation on riparian (flood plain) woodlands. He has conducted studies of hydrology, fluvial geomorphology and especially, the ecophysiology of riparian trees. These multidisciplinary studies have shared the theme of investigating environmental consequences of damming and instream flow regulation. He is currently particularly involved in the development of dam operations strategies for the conservation and restoration of riparian woodlands in western North America. He has conducted studies of riparian cottonwoods in Alberta British Columbia, Oregon, Idaho, Montana, Nevada, and Utah.

5 recent and relevant publications

Mahoney, J.M. and S.B. Rood. 1998. Streamflow requirements for cottonwood seedling recruitment - an integrative model. *Wetlands* 15: 634-645.

Rood, S.B., A.R. Kalischuk and J.M. Mahoney. 1998. Initial cottonwood seedling recruitment following the flood of the century of the Oldman River, Alberta, Canada. *Wetlands* 15: 557-570.

Rood, S.B. and J.M. Mahoney. 1996. River damming and riparian cottonwoods along the Marias River, Montana. *Rivers*. 5(3):195-207.

Rood, S.B. and J.M. Mahoney. 1990. The collapse of poplar forests downstream from dams in the Western Prairies: probable causes and prospects for mitigation. *Environmental Management*. 14:451-464.

Rood, S.B. and S. Heinze-Milne. 1989. Abrupt downstream forest decline following river damming in southern Alberta. *Can. J. Bot.* 67:1744-1749.

Mary Louise Polzin

Comp. 4 Site 4A RR#1
Elko B.C.
V0B 1J0
(250) 529-7759
mlpolzin@elkvalley.net

EDUCATION:

1998 M.Sc. Department of Botany, University of Lethbridge, Lethbridge, Alberta
1994 B.Sc. Department of Biology, University of Lethbridge, Lethbridge, Alberta

BACKGROUND: M.L. Polzin is an ecologist specializing in the ecology of riparian landscapes and the physiological ecology of riparian plants. From May 1996 to August 1998, she has been working on her master of science thesis which involved the riparian ecology of the Kootenay, Elk and Fisher rivers with the Kootenay crossing the international boarder into Montana and the Fisher River, MT. Her research focused on the ecology of riparian plants concentrating on black cottonwoods. The research included the physiological and morphological responses of black cottonwoods to extreme flood events and flow attenuation. The impacts of stream-flow modifications on the riparian plant communities below the Libby Dam was addressed as well as possible mitigation to decrease some of the negative affects. Field work in September 1998 occurred along the lower Snake (Hells Canyon) and Salmon River Corridors focusing upon the ecology of the riparian plant communities. M.L. Polzin is presently continuing the research on the Kootenay and Elk rivers for Dr. Rood at the University of Lethbridge, Alberta.

EMPLOYMENT HISTORY:

Research assistant: Biology Dept., University of Lethbridge, Alberta 1998
Field work assistant: Idaho Power project, Snake dams decommissioning 1998

RELEVANT PUBLICATIONS:

Jamieson B., G. Allen., S.B. Rood, and M.L. Polzin. 1997. Elk Valley Riparian Assessment for Columbia Basin Fish & Wildlife Compensation Program, S.B. Rood and M.L. Polzin were consultants for The Life History of Black Cottonwoods.

Polzin, M.L. 1998. River and Riparian Dynamics and Black Cottonwoods in the Kootenay River Basin, British Columbia and Montana, M.Sc. thesis, University of Lethbridge, Lethbridge, Alberta, pp 224.

Rood S.B., A.R. Kalischuk, T. Bond, L. Bridges, R. Cain, P. Fay, M. Heller, K. Larter, K. Mikkelsen, G. Neufeld, M.L. Polzin, C. Rogers, J. Schmaltz, C. Vair and L. Weaver. 1996. Canyonlands Cottonwoods: Mortality of Fremont Cottonwoods in the Matheson Wetlands Preserve along the Colorado River at Moab, Utah, Submission to: The Nature Conservancy, Moab Project Office.

Michael F. Merigliano Jr.

P.O. Box 453,
Driggs, Idaho 8390422

Ph(208) 354-8289

Education

Ph.D. Ecology., December 1996. University of Montana. Missoula, Montana

M.S. Ecology., May 1994. University of Montana. Missoula, Montana

B.S. Forest Resources Management. May 1981. University of Idaho. Moscow, Idaho

A.A.S. Forestry, May 1978. Paul Smith's College. Paul Smiths, New York

Related Work Experience

Ecologist. Cooperative agreement between U.S. Geological Survey, Biological Resources Division and University of Montana. August 1996 to present. Collaboration on various research projects related to riparian vegetation. Data collection and analysis. Development and critique of research plans. Writing research publications.

Instructor. Teton Science School, Kelly, WY. July 26 to 28, 1998. Team taught a River Channels (professional seminar) course with Luna Leopold, Scott McBain, and William Trush.

Instructor. Idaho State University. January and February, 1998. Team-taught a continuing-education course in local natural history and ecology with Michael B. Whitfield, Mary Maj, and Blair Baldwin.

Research Assistant. University of Montana. May 1991 to October 1996. Research on cottonwood forests, including tree and stream deposit aging, assessing stream channel changes, streamflow analysis, relating edaphic factors to vegetation composition and plant moisture stress. Sampled vegetation for riparian vegetation classification in eastern Idaho.

Teaching assistant. University of Montana. January to May, 1991 and 1993. Assisted teaching of technical writing to undergraduate and graduate students of several majors (1991). Developed and taught lab portion of forest ecology course undergraduate and graduate students in forestry (1993).

Field Biologist. Montana State University. Winters of 1988-89, 1989-1990. Field data collection of bald eagle habitat use and behavior. Extensive use of radio telemetry. Banding and trapping eagles.

Relevant Publications

Merigliano, M. F. 1994. A natural history of the South Fork Snake River, emphasizing geomorphology, hydrology and vegetation. M. S. thesis. The University of Montana. Missoula, MT. 278 p.

Merigliano, M. F. and D. F. Potts. 1994. Snake River channel changes below the Palisades reservoir in eastern Idaho. *In: Effects of human-induced changes on hydrologic systems.* American Water Resources Association. Bethesda, Maryland pp. 639-648

Merigliano, M. F. 1996. Ecology and management of the South Fork Snake River cottonwood forest. Bureau of Land Management Technical Bulletin 96-9. 79 p. + appendices.

Merigliano, M. F. 1996. Flood-plain and vegetation dynamics along a gravel bed, braided river in the northern rocky mountains. Ph.D. Dissertation. The University of Montana. Missoula, MT. 182 p.+ 17 map plates.

Merigliano, M. F. 1997. A primer on cottonwoods. *Kelseyia* 10(3):1,6

Merigliano, M. F. 1997. Hydraulic geometry and stream channel behavior: an uncertain link. *Journal of the American Water Resources Association* 33(6):1327-1336.

Merigliano, M. F. 1998. Cottonwood and willow demography on a young island, Salmon River, Idaho. *Wetlands* 18(4):571-576.

Merigliano, M. F. 1998. Big weeds and destructive floods: Cottonwood ecosystems and related conservation issues. *Sage Notes (Idaho Native Plant Society)* 20(2):7-8. (Republished in *The Retort (Idaho Academy of Science)* 34(2):16-17.

JOAN M. DUNLAP

3236 NE 91st St,
Seattle, WA
98115

Wk: (206) 685-8755
Ho: (206)522-2708

EDUCATION

Ph.D., Forest Resources, May 1991, University of Washington, Seattle, WA. Dissertation title: Genetic Variation in Natural Populations of *Populus trichocarpa* T. & G. from Four River Valleys in Washington
M.S., Wildland Resource Science, December 1981, University of California, Berkeley, CA.
B.S., Conservation of Natural Resources, June 1977, University of California, Berkeley, CA.

PROFESSIONAL EXPERIENCE

Research Consultant/Research Analyst, College of Forest Resources, University of Washington, Seattle, WA. 7/97 -Present. Manage poplar field data and database for the UW/WSU Poplar Research program. Direct operations of field projects, analyze data (e.g., SAS, Excel), write reports to and interact with poplar (PMGC) Cooperative members.

Forest Geneticist, B.C. Ministry of Forests (contract), Vernon, British Columbia. 3/95. Assisted with field collection of poplar in the province. Advised on trial designs to obtain information on genecology and genetic improvement of poplar. Presented three seminars on genetic variation in black cottonwood.

Biological Statistician, National Marine Mammal Laboratory, Seattle, WA. 8/92 - 12/94. Computer programming and statistical analyses of behavioural data on northern fur seals of the Pribilof Islands.

Forest Biologist, United States Forest Service (contract), Pacific Southwest Forest & Range Experiment Station, Albany, CA. 5/92 - 7/92. Carried out vegetation surveys in two proposed genetic conservation areas in the El Dorado National Forest. Aerial photo interpretation; field surveys of ground features and forest plants/trees; data analysis; two reports.

PROFESSIONAL QUALIFICATIONS/EXPERTISE: For a period of 8 years (1984-1992), I was the primary person in charge of implementing and carrying out research on the genecology of native black cottonwood trees growing in Washington state. I was involved in writing the research proposal, collecting clonal material in the native populations, establishing provenance trials, conducting the statistical analyses and reporting the findings. As a result, we have contributed to our understanding of spatial variation in black cottonwood populations along rivers. Because of this and other poplar research, we can now make recommendations about what material will more likely to succeed in riparian restoration projects. Due to my interest in native populations and the environmental variables affecting these trees, I have also participated in the B.C. Ministry of Forests poplar program as a Forest Geneticist in 1995. I continue with my involvement in poplar research and application as a Research Consultant with the University of Washington.

PUBLICATIONS:

- Dunlap, J.M. and R.F. Stettler. 1998. Genetic variation and productivity of *Populus trichocarpa* and its hybrids. X. Trait correlations in young black cottonwood from four river valleys in Washington. *Trees* 13: 28-39.
- Dunlap, J.M., P.E. Heilman, and R.F. Stettler. 1995. Genetic variation and productivity of *Populus trichocarpa* and its hybrids. VIII. Leaf and crown morphology/variation and productivity of *Populus trichocarpa* and its hybrids. VIII. Leaf and crown morphology of native black cottonwood clones from four river valleys in Washington. *Can. J. For. Res.* 25: 1710-1724.
- Dunlap, J.M., P.E. Heilman, and R.F. Stettler. 1994. Genetic variation and productivity of *Populus trichocarpa* and its hybrids. VII. Survival and two-year growth of native black cottonwood clones from four river valleys in Washington. *Can. J. For. Res.* 24: 1539-1549.
- Dunlap, J.M., J.H. Braatne, T.M. Hinckley, and R.F. Stettler. 1993. Intraspecific variation in photosynthetic traits of *Populus trichocarpa*. *Can. J. Bot.* 71: 1304-1311.

JON D. JOHNSON

EDUCATION

- 1981 Ph.D. (Tree Physiology/Soils), Oregon State University
1977 MS (Forestry/Plant Physiology), University of Minnesota
1975 BS (Forest Biology, summa cum laude), Colorado State University

CURRENT EMPLOYER AND RESPONSIBILITIES

1997-present Associate Professor, Department of Natural Resource Sciences, Washington State University - Puyallup. Director of WSU Poplar Research Program which entails overseeing the development and testing of hybrid poplars for growth and disease resistance, managing clone arboreta for breeding purposes, and conducting research on the production physiology of fast growing species including *Populus* and *Salix*.

ACADEMIC APPOINTMENTS

- 1988-97 Associate Professor, Department of Forestry, University of Florida
1984-88 Assistant Professor, Department of Forestry, University of Florida
1981-84 Assistant Professor, Department of Forestry, Virginia Polytechnic Institute and State University, 1981-1984

EXPERTISE

Stress ecophysiology of forest trees, including effects of abiotic (water, nutrition, carbon dioxide, air and soil pollution) and biotic (disease) stresses on the physiological response from the biochemical to whole tree level.

RECENT AND RELEVANT PUBLICATIONS

- Johnson, J.D., M. Michelozzi and R. Tognetti. 1997. Carbon physiology of *Quercus pubescens* growing in the Bossoletto CO₂ spring of central Italy. pp.148-164. In: Plant Responses to Elevated CO₂ : Evidence from Natural Springs.(eds. Raschi, A., F. Miglietta, R. Tognetti, and P. van Gardingen). Cambridge Press, Cambridge. 272p.
- Tognetti, R., J.D. Johnson, and M. Michelozzi. 1997. Ecophysiological responses of *Fagus sylvatica* L. seedlings to changing light conditions. I. Interaction between photosynthetic acclimation and photo-inhibition during simulated canopy gap formation. *Physiol. Plant.* 101:115-123.
- Johnson, J.D., R. Tognetti, M. Michelozzi, S. Pinzauti, G. Minotta and M. Borghetti. 1997. Ecophysiological responses of *Fagus sylvatica* L. seedlings to changing light conditions. II. The interaction of light environment and soil fertility on seedling physiology. *Physiol. Plant.* 101:124-134.
- Tognetti, R., J.D. Johnson and M. Michelozzi. 1995. The response of European beech (*Fagus sylvatica* L.) seedlings from two Italian populations to drought and recovery. *Trees* 9:348-354.
- Johnson, J.D., D.P. Byres and T.J. Dean. 1995. Diurnal water relations and gas exchange of two slash pine (*Pinus elliottii* Engelm.) families exposed to chronic ozone levels. *New Phytol.* 131:381-392.

Section 10. Information/technology transfer

Data from this work will be compiled in reports that be provided to resource managers, hydroelectric system managers and biologists working in the Basin, both in Canada and the USA. The information, once vetted by the NPPC and others, will be published in refereed journals. A database on cottonwood riparian systems will be provided to BPA and other interested parties.

Congratulations!